



DME and its Potential for Improved Air Quality and Local Resilience

LA County Solid Waste Management Task Force
Alternative Technology Advisory Subcommittee



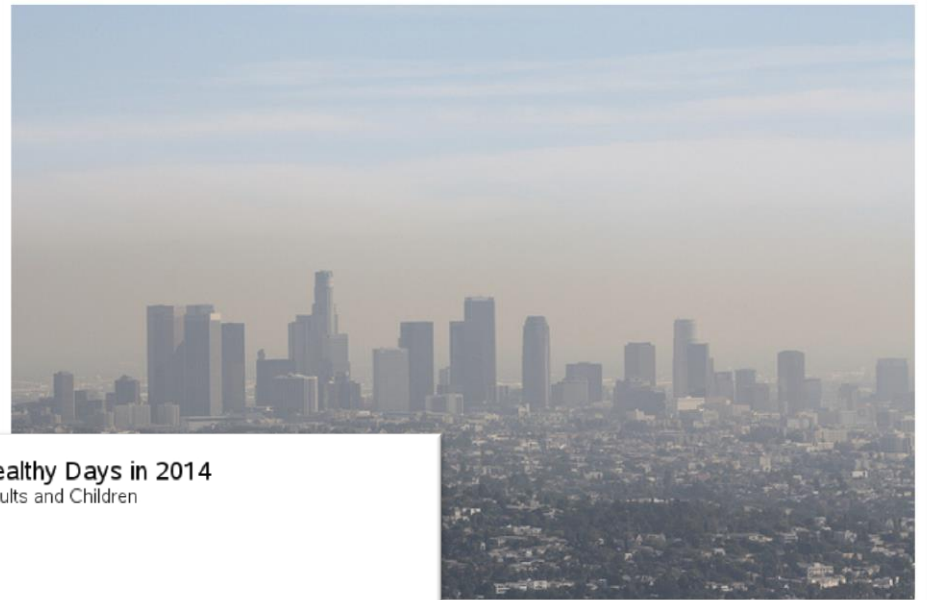
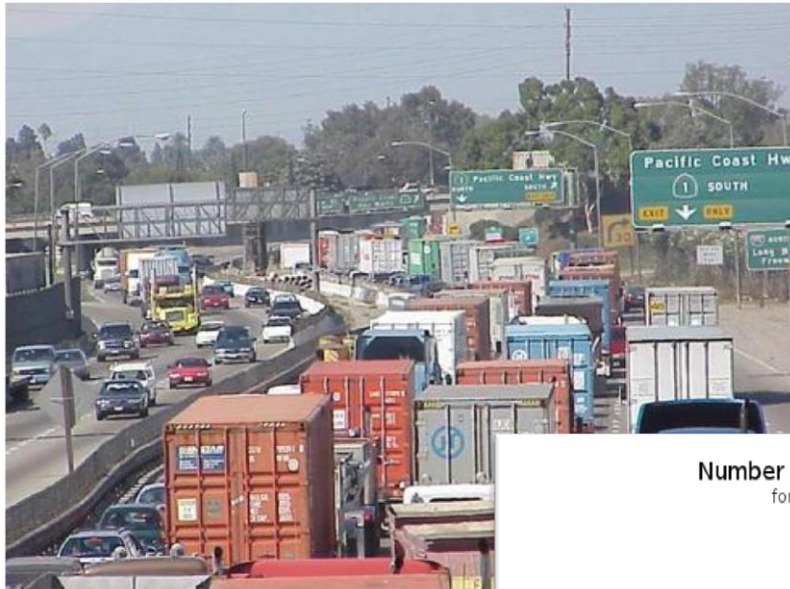
Urban Waste



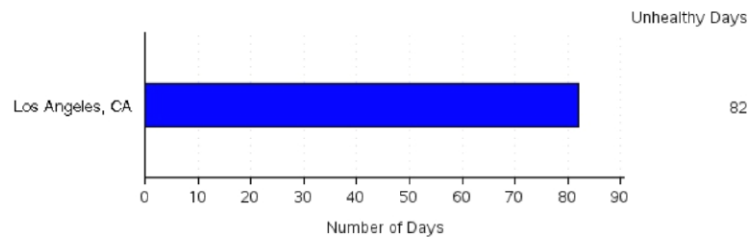
Los Angeles County sent more than 8.6 million tons of waste to landfills in 2012 and the flow of waste to area landfills could hit capacity by next year if nothing changes, officials said. This photo was taken at the Puente Hills Landfill in Industry, which has since closed. Photo by Robert Staley

Air Quality & Vehicle Emissions

Increasing emissions and efficiency regulations



Number of Unhealthy Days in 2014
for Older Adults and Children



Solution

Utilize waste streams to create own energy supply...



Landfill Gas

Food Waste

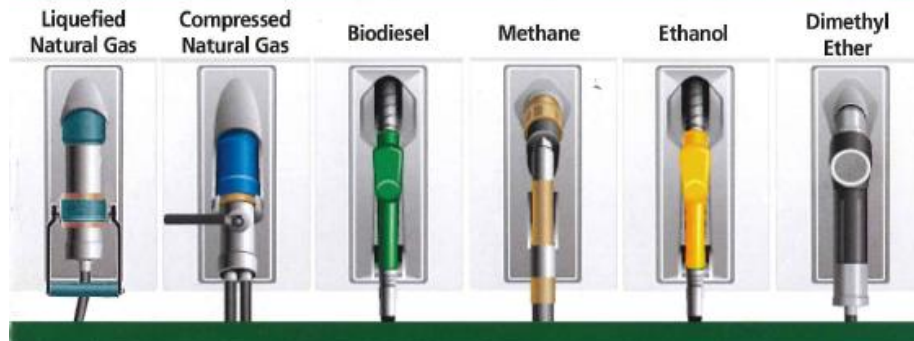


**Industrial
Waste
Streams**

...creating circular economies and local resiliency

Why Another Fuel?

Transport Topics SPECIAL REPORT



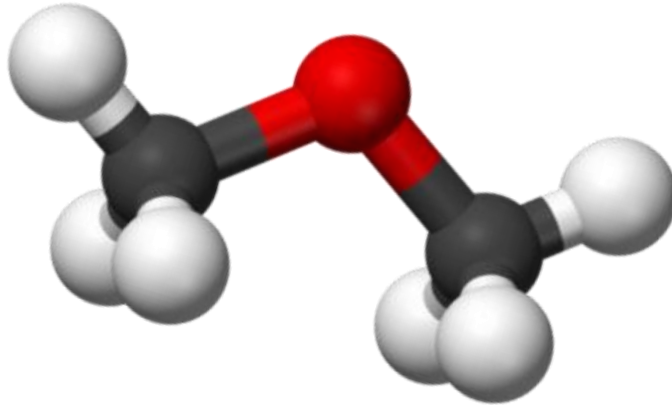
ALTERNATIVE FUELS

SAFETY • MAINTENANCE • INFRASTRUCTURE
EFFICIENCY • ENVIRONMENT • REGULATION



**Simple Fuel.
Simple Engine.
Simple Infrastructure.**

DME Simple Fuel



Dimethyl ether (DME)

- **Diesel-like Performance**
 - Efficiency and torque of diesel engine
 - High cetane, compression-ignition fuel
 - NO carbon-carbon = NO part. matter = NO DPF
- **Propane-like Handling**
 - Stored in propane cylinders/tank, only change seal

- Biogas-based Oberon DME now qualifies under the Renewable Fuel Standard (RFS)
- 68% reduction in greenhouse gases
- Able to generate RINs credits (D-3 and D-5)



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 12 2014

OFFICE OF
AIR AND RADIATION

Rebecca Boudreaux, Ph.D.
President
Oberon Fuels, Inc.
2223 Avenida de la Playa
Suite 205
La Jolla, California 92037

Dear Dr. Boudreaux:

You petitioned the Agency on behalf of Oberon Fuels, Inc. ("Oberon") to approve a pathway for the generation of cellulosic and/or advanced biofuel fuel RINs under the renewable fuel standard ("RFS") program for the production a renewable diesel substitute, dimethyl ether ("DME"), made from waste-derived biogas. Oberon's biogas-to-DME process uses electricity purchased from the grid and available onsite waste-derived biogas for process energy and approved waste-derived biogas from onsite and offsite sources as the feedstock to produce DME using a novel three-step production process (the "Oberon process").

Through the petition process described under 40 CFR 80.1416, Oberon submitted data to the EPA to perform a lifecycle GHG analysis of the Oberon pathways. This analysis involved a straightforward application of the same methodology and much of the same modeling used for the March 2010 RFS rule (75 FR 14670) and the July 2014 RFS rule (79 FR 42128). The difference between this analysis and the modeling completed for previous rules is the evaluation of a different fuel production process and type of renewable fuel.

The attached document "Oberon Fuels Request for Fuel Pathway Determination under the RFS Program" describes the data submitted by Oberon, the analysis conducted by the EPA, and our determination of the lifecycle greenhouse gas emissions associated with the fuel production pathways described in Oberon's petition.

Based on our assessment, renewable DME produced using biogas from landfills, municipal wastewater treatment facility digesters, agricultural digesters, and separated MSW digesters, and biogas from the cellulosic components of biomass processed in other waste digesters through the Oberon pathways qualifies under the Clean Air Act for cellulosic biofuel (D-code 3) RINs. Renewable DME produced from biogas from waste digesters processing renewable biomass that is assumed non-cellulosic through the Oberon pathways qualifies for advanced biofuel (D-code 5) RINs. To be eligible for RINs, the fuel must meet the definitional requirements associated with cellulosic biofuel or advanced biofuel, as appropriate, be made from renewable biomass as defined in EPA regulations, and be demonstrated pursuant to 80.1426(f)(10)(ii) and (11)(ii) to be used as a transportation fuel.

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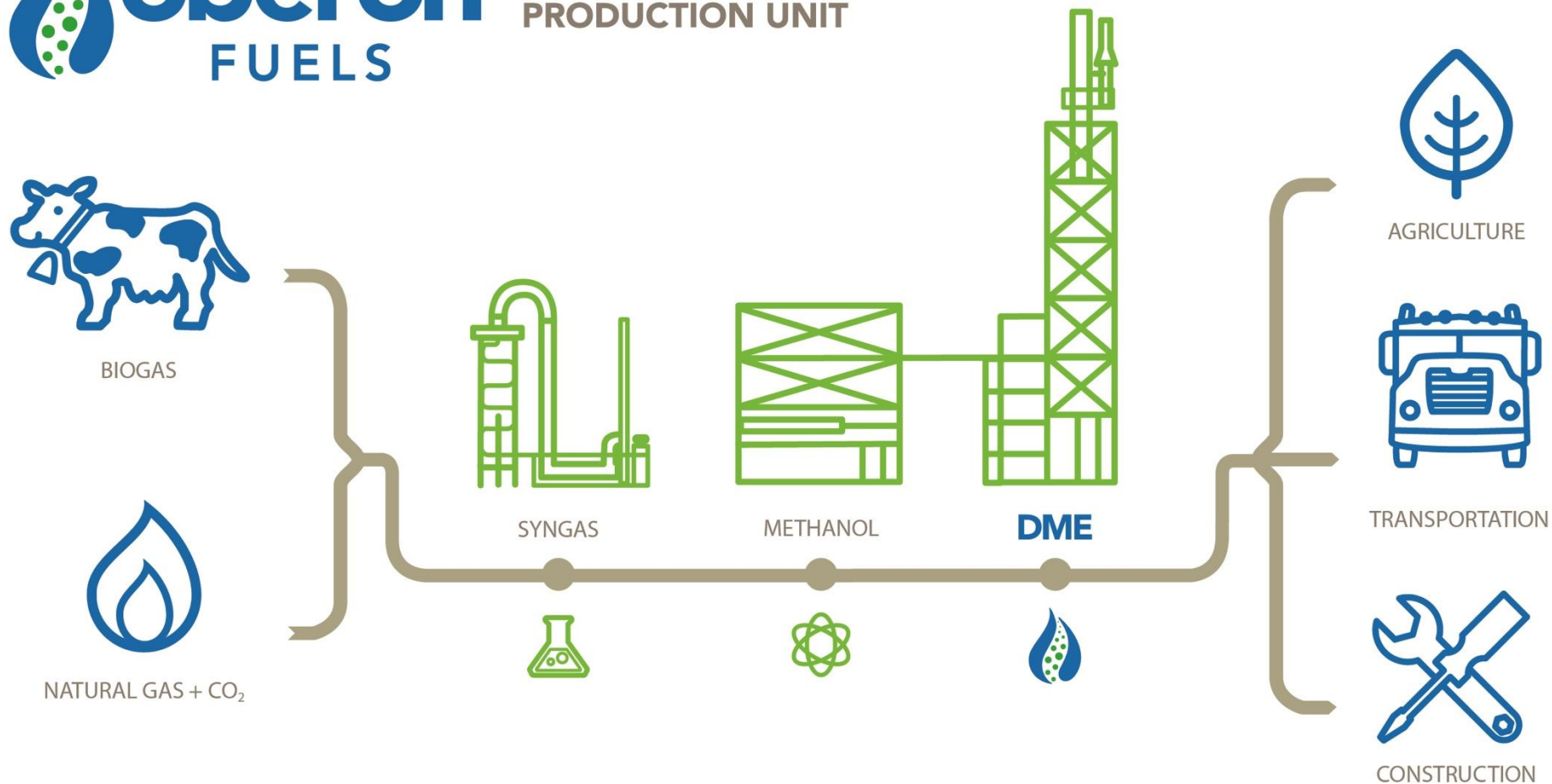
Local Feedstocks

Local Fuel Production

Local Fuel Consumption

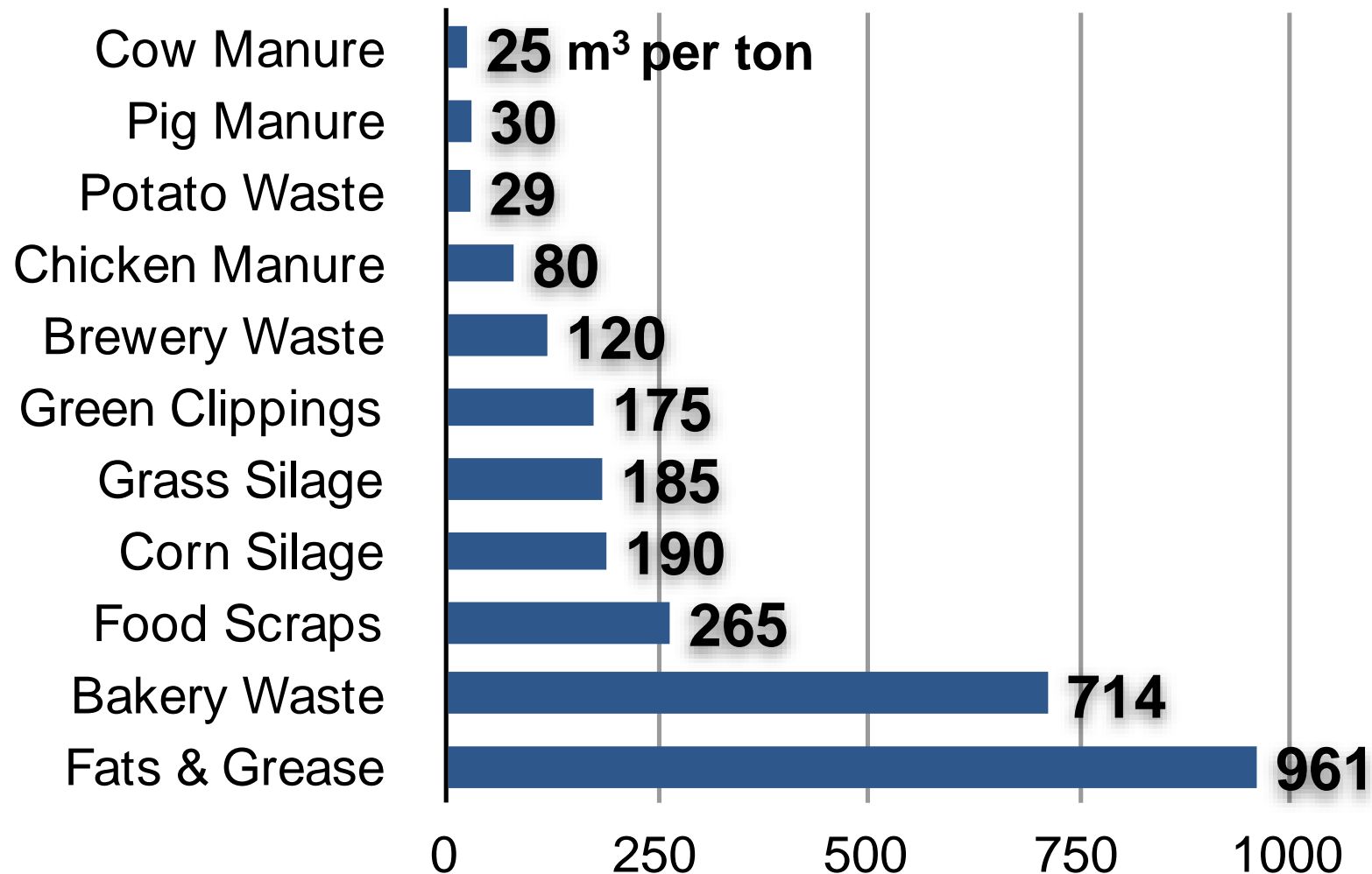


SMALL SCALE PRODUCTION UNIT



10 Cost-effectively converts methane and CO₂ to DME

Made from Wasted Resources



Process by the Numbers

- **Daily Production:** 10,000 DME gal. (37,854 L)
 - PER DAY: 5,300 diesel gallon eq. (28 tons)
 - PER YEAR: 1.8 million diesel gallon eq., (9,700 tons)
- **Service:** 80-100 regional haul trucks
- **Natural Gas:** 1.3 million standard cubic feet/day (36,812 cubic meters/day)
- **Biogas:** 1.6 million standard cubic feet/day (45,307 cubic meters/day)
 - 175 tons food waste, 59 tons fats & grease/day

DME Production: Oberon Plant



DME Simple Engine



DME Simple Engine

- **Compression Ignition (“Diesel Cycle”)**
 - Efficiency and torque of diesel
 - Runs on 100% DME, requires modified fuel system
 - Remaining engine design is the same from combustion chamber to exhaust, except...
- **Simplified after-treatment systems**
 - **NO** part. matter generated when DME combusts = **NO** diesel particulate filter (DPF)
 - Since no part. matter, easier to control NOx

DME Engine Development

Diesel-like Performance, Propane-like Handling



DME fuel pump at ENN
service station



BioDME Project

Partners include
TOTAL, Preem, Delphi,
ETC, Chemrec, &
Haldor Topsoe



上汽集团
SAIC MOTOR

NAVISTAR®

ISUZU



DME Simple Infrastructure



DME Simple Infrastructure

- **Storage & Dispensing**
 - Simple steel propane storage tanks
 - Inexpensive propane dispensing
 - Diesel-like fueling times
 - Tanks & dispensers only require seal changes
- **Safety**
 - Handles like propane
 - Liquid ~ 73 psi (liquid inj. throughout engine)
 - **NO** cryogenics or high compression

DME Status



Fuel-grade DME

- Produced in southern CA by Oberon Fuels
- 1st known commercial DME catalytic distillation column



DME-powered Trucks

Demonstrations running in US



ASTM Specification

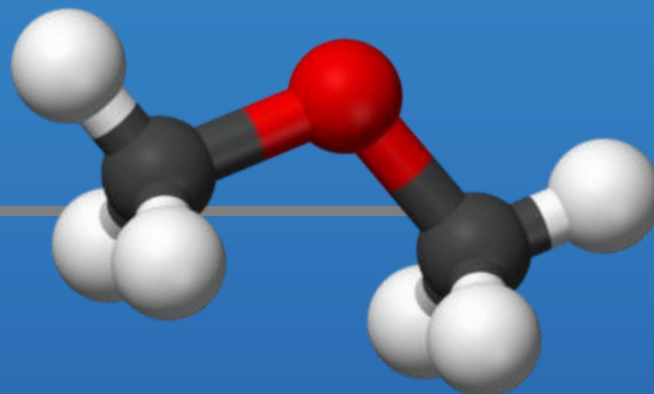
Published 2014
ASTM D7901



Legal Fuel in the US

With CA's recent change in state Code of Regulations, DME now legal to sell as a fuel in *ALL* 50 states

Contact Info



Dan Goodwin

Director of Business Development

dan@oberonfuels.com

(619) 255-9361, x102



Who is Oberon Fuels?

- **Company Background**

- San Diego-based company
- Founded Nov 2010
- Leads the market development of DME as a transportation fuel
- 1st to produce fuel-grade DME in North America

- **Technology**

- Developed process to cost effectively convert methane and carbon dioxide to dimethyl ether (DME)
- Pilot plant online in southern California (Imperial Valley Region, Brawley, CA)



Pilot Plant
June 6, 2013
(Imperial Valley)

Oberon Solution

Connecting feedstocks with end-use applications

- **Monetizing** waste stream with small-scale production units
- **Creating** regional markets that can use the end products, distributed production
 - Resiliency, sustainability, controlling own fuel supply
- **Developing** small-scale production unit to convert to higher-valued product such as DME
- **Establishing** a market for DME as a transportation fuel/diesel replacement

Lifecycle Analysis of DME

Table 1: Lifecycle GHG Emissions of DME from the Oberon Process (kgCO₂e/mmBtu)³

Lifecycle GHG Emissions		
Lifecycle Stage	Oberon DME (kg CO ₂ eq/mmBtu-DME)	2005 Diesel Baseline (kg CO ₂ eq/mmBtu-diesel)
Upstream biogas recovery	2	0
Fuel production	32	18
Tailpipe emissions	70	79
Avoided flaring emissions	-73	0
Total emissions	29	97
Change from diesel baseline	68%	

- As determined by EPA
- Lifecycle GHG emissions of Oberon bioDME vs. 2005 baseline diesel